You will submit your solution to this assignment to the Curator System (as `HW1`). Your solution must be either a plain text file (e.g., NotePad) or a MS Word document; submissions in other formats will not be graded.

Partial credit will only be given if you show relevant work.

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1. [20 points] Using any relevant theorems from the notes, conjecture a simple function *g* such that *f* is Θ(*g*), and prove that your conjecture is correct if:

$$f(n) = n^2 \log n + n^3 + 1000$$

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2. [20 points] Let α be an arbitrary positive constant, and define two functions:

$$f(n) = \log n \text{ and } g(n) = n^{\alpha}$$

Using any theorems from the notes, prove that f is O(g) but f is not Θ(g).

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3. [20 points] Suppose that f and g are non-negative functions such that f is Θ(g). Is it necessarily true that:

$$2^{f(n)} \text{ is } \Theta\left(2^{g(n)}\right)$$

If so, prove it. (You may assume that the limit referred to in Theorem 8 exists.) If no, give a specific counter-example and show that it is a counter-example.

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4. [20 pts] Assume a system uses a hard drive with the following physical characteristics:

total capacity	128 GB
# of platters	8
# of tracks per surface	16384
# of sectors per track	2048
cluster size	4 KB
spindle speed	10000 RPM
head start time	1 ms
track to track seek time	0.01 ms

In answering the following questions, express all final time values to the nearest hundredth of a millisecond (8.33 ms).

a) What is the average random head seek time for this drive?

b) What is the average rotational latency for this drive?

c) What is the average total time required to read one randomly-chosen sector from this drive?

d) What is the average total time required to read a file of 10 MB from this drive if the clusters are randomly scattered on the drive?

5. [20 points] Consider solving a problem using an algorithm whose complexity is $\Theta(N^2)$. Estimate the running time of the algorithm if:

   a) $N = 2^{12}$ (4096) and the hardware is capable of executing 2^{24} instructions per second.

   b) $N = 2^{16}$ (65536) and the hardware is capable of executing 2^{24} instructions per second.

   Express your answers in days, hours, minutes and seconds. (Not in total seconds unless the time is shorter than 1 minute.)